THE EXPLOSIVES ENGINEER

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Forerunner of Progress in Mining, Quarrying, Construction

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Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

In his article on page 103, John C. Machisak summarizes the results of the National Safety Competition of 1956. The editorial staff of THE EXPLOSIVES ENGINEER joins with Mr. Machisak in extending congratulations to the winners in six group classifications, and to all the enrolled companies that strive to promote safer working conditions for the men employed in their mines and quarries.

Some of the highlights of the summary include a combined injury-frequency rate of 18.980 per million man-hours of exposure, the lowest ever recorded in the 32-year history of the contest. Also, perfect safety records were achieved by 200 (38 per cent) of the 525 mines and quarries enrolled.

The National Safety Competition was started in 1924 under the joint sponsorship of the Bureau of Mines and THE EXPLOSIVES ENGINEER. Over the years, the participants in these annual contests have made outstanding records in accident prevention: both injury-frequency and injury-severity rates have turned appreciably downward, while the trend of "injury-free operations" has tended steadily upward. The statistical history of the mines and quarries enrolled shows they regularly establish more favorable records than other similar operations not enrolled.

Any underground mine, open-pit operation, or quarry in the United States is eligible for enrollment in the National Safety Competition. Applications for enrollment and copies of the rules of the contest will be forwarded upon written requests to Accident Analysis Branch, Bureau of Mines, Washington 25, D. C.

• • •

During early development work in the Maryneal, Texas, limestone quarry of Lone Star Cement Corporation, drilling and blasting were done wherever the greatest amount of limestone could be obtained within the shortest time. This resulted in an irregular face with some hard-to-work islands in the quarry.

After some discussion and experimenting, the face was surveyed and staked carefully, and all blasting activities followed a definite plan. This gradually straightened out the zig-zags. Today, company crews work in a straight, clean quarry face that ranges from 15 to 45 ft. in height.

A description of the activities in the Maryneal quarry and plant is presented by Lewis Nordyke, beginning on page 116.

• • •

The Dresser Trap Rock Company's quarry in Wisconsin has been worked continuously since 1914. The formation is a hard, tough, and dense basalt. Through the years, various types of drilling and blasting have been tried. Careful examination of the records convinced the company management that more tons of this rock were broken per pound of explosives at less cost per cubic yard by the coyote-tunnel method than with any other blasting procedure.

The results of a three-tunnel blast in this quarry on May 2, when the detonation of 93,150 lb. of Hercules® dynamite brought down 870,000 tons of broken basalt onto the quarry floor, are described by William L. Harley on page 121.

• • •

Erratum: In our May-June, 1957, issue, the caption under the illustration at the lower left of page 74 reads, in part, "portable Ingersoll-Rand drill." This should have read, "portable Joy drill."

We regret that this error was not detected before the issue was printed.

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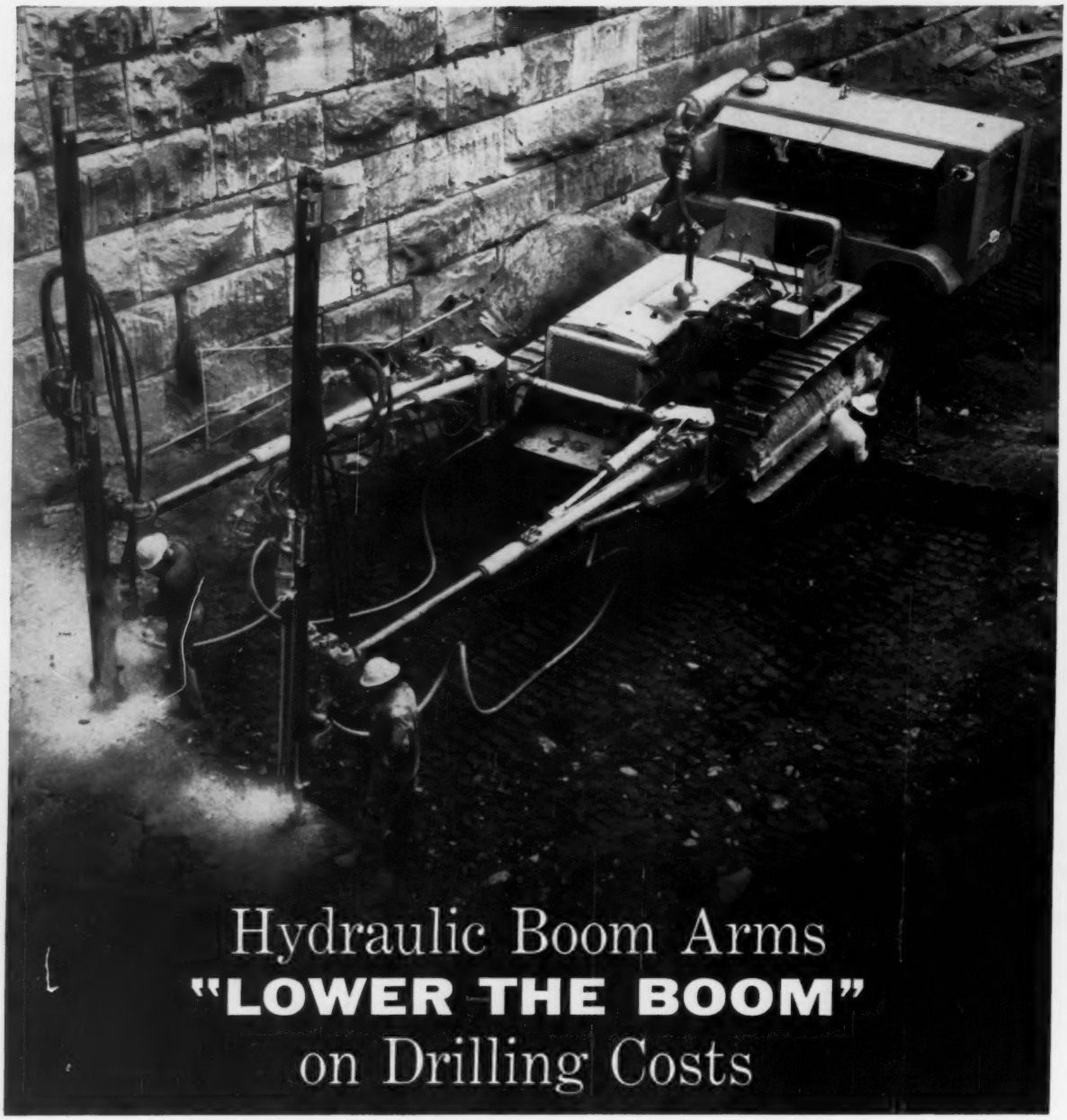

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GEORGE JOHN CLARK

George John Clark

PRESIDENT

READING ANTHRACITE COMPANY

A Biography

GEORGE JOHN CLARK, president of Reading Anthracite Company, is an outstanding leader in the business of mining and preparation of coal. Thorough training in the fundamentals, capacity for hard work, long years of concentrated effort, understanding and appreciation of his fellow men, have earned for him the respect and admiration of his associates in the anthracite industry.

George, as he is known to his friends and associates, was born March 11, 1911, in Upper Augusta Township, Northumberland County, Pennsylvania, the son of Allen and Elsie (Zimmerman) Clark. He received his early education in the local grade schools and in Sunbury (Pennsylvania) High School. He enrolled in Rensselaer Polytechnic Institute at Troy, New York, from where he was graduated in 1933 with a degree of Civil Engineer.

Immediately after his graduation from Rensselaer Tech, George went to work for The Philadelphia and Reading Coal and Iron Company as a chainman in the Engineering Department. During the next ten years, he was advanced to various positions of responsibility, culminating in his appointment as Division Engineer of the company's Pottsville Division.

In 1946, the Philadelphia and Reading company formed a subsidiary organization named Shen-Penn Production Company to concentrate on large-scale strip-mining operations in the coal deposits at its property in and around Shenandoah, Pennsylvania. George was made chief engineer of the new company. One year later, he was elected Shen-Penn's president.

In 1951, he was brought back to The Philadelphia and Reading Coal and Iron Company to take over the duties of vice president and general manager. He continued in that capacity after the company's name was changed to Reading Anthracite Company on January 1, 1956. In September of that year, George was elected to the presidency of the company, the position he holds today.

George was honored by the governor of Pennsylvania with appointments to membership on the Anthracite Mine Inspectors Board; the Mine Drainage Commission; and the Anthracite Committee of the State of Pennsylvania.

His other business associations include membership on the board of directors of the Anthracite Institute; a member of the Advisory Council of American Mining Congress; a member of the Anthracite Section of American Institute of Mining, Metallurgical, and Petroleum Engineers; a member of the Conciliation Board of the Anthracite Industry, District 9; a member of the Anthracite Operators Wage Agreement Committee; and a member of the Pennsylvania Society of Professional Engineers.

Other affiliations include memberships in Newcomen Society; Pottsville Chamber of Commerce; the Advisory Board of Pottsville Center, Pennsylvania State University; the Regional Executive Committee, Boy Scouts of America; and the Pottsville Chamber of Commerce.

George is also president of Appalachian Trail Council of the Boy Scouts of America; on the boards of directors of the Schuylkill County Crippled Children's Association; the Heart Association; and the YMCA.

His clubs are the Pottsville, the Schuylkill, and the Lions International.

George John Clark married Myrtle Lentz on September 6, 1932, in Sunbury, Pennsylvania. They have two daughters, Nancy and Susan. The family home is at 601 Edwards Avenue in Pottsville.

A heavy schedule of business and civic commitments leaves little time for relaxation. However, like most successful business executives, George manages to arrange hunting and fishing expeditions with his family and friends. His enthusiasm for casting and trolling in nearby waters is apparent from a recent remark, "I'm after that 'big one' that always seems to get away."

THE WINNERS

1956

Anthracite
GOODSPRING MINE
PENAG COAL COMPANY
Goodspring, Pennsylvania

Bituminous-Coal
EDGEWATER MINE
UNITED STATES STEEL CORPORATION
Wylam, Alabama

Metal
BUCK MINE
PICKANDS MATHER & CO.
Caspian, Michigan

Nonmetallic
BELL MINE
WARNER COMPANY
Bellefonte, Pennsylvania

Open-Pit
EMBARRASS MINE
PICKANDS MATHER & CO.
Biwabik, Minnesota

Quarry
ALPENA QUARRY
WYANDOTTE CHEMICALS CORPORATION
Alpena, Michigan

"Let the worker carry around with him a mental picture of his wife and child, whose happiness depends upon his safe return after the day's work, and these loved ones become his surest sentinels of safety."

January 1925 — The Explosives Engineer

THE National Safety Competition OF 1956

The 525 mines and quarries participating established a combined injury-frequency rate of 18.980 per million man-hours of work, the lowest recorded in the 32-year history of the competition

JOHN C. MACHISAK*

ACCIDENT prevention is a potent and challenging tool available to industry for conserving the Nation's manpower. This applies especially to mining and quarrying operations. To stimulate and maintain the enduring interest of these two industries in accident prevention, the United States Bureau of Mines, in cooperation with THE EXPLOSIVES ENGINEER, sponsored the National Safety Competition in 1924. Over the years the participants in these annual contests have made outstanding records in accident prevention: both injury-frequency and injury-severity rates have turned appreciably downward, while the trend of the "injury-free operations" has tended steadily upward, indicating very forcefully that injuries NEED NOT HAPPEN.

There were 525 participants in the 1956 competition. These mines and quarries established a combined frequency rate of 18.980 per million man-hours, the lowest recorded in the 32-year history of the competition. The injury-severity rate of 4.974 per thousand man-hours was not as favorable as the record-low rate of 3.872 made in the 1955 competition but was the fourth lowest in the history of the contest.

The 1956 competition record showed clearly the effectiveness of the contest in promoting safety at plants where aggressive safety measures are regarded as an important part of the daily operation. The National Safety Competition serves a very useful purpose in stimulating and holding the interest of management and employes in accident-prevention work. The statistical history of the operations enrolled in the competition shows that they regularly establish more favorable records than other similar operations not enrolled in the competition.

Awards to Winners

National recognition is given the mines and quarries that won top safety honors in six group classifications.

*Acting Chief
Branch of Accident Analysis
Division of Safety, Bureau of Mines
U. S. Department of the Interior

GOODSPRING MINE EMPLOYES: These employes of Penag Coal Company's Goodspring Mine (top, Slope No. 2; bottom, Slope No. 3) made the best record among the anthracite underground mines enrolled in the 1956 National Safety Competition.

Each of the six operations that made the best safety record in its group is awarded a bronze Sentinels of Safety trophy and a Sentinels of Safety flag, donated by THE EXPLOSIVES ENGINEER. In addition, each employe of the six winning plants is awarded an individual Certificate of Achievement in Safety by the Bureau of Mines in recognition of his contribution to the plant safety record. These six groups include four kinds of underground mines – anthracite, bituminous-coal, metal, and nonmetallic minerals – and two types of surface operations – quarries (regardless of kind of stone produced) and open-pit mines (regardless of kind of mineral produced.) The winner in each group is the mine or quarry that was operated during the contest year with the lowest injury-severity rate (days lost through disabling injuries per thousand man-hours of work). If two or more participating operations are injury-free or their injury-severity rates are identical, the winner is the one that operated the greatest number of man-hours.

In 1956, the total worktime of the participating mines and quarries was slightly more than 126 million man-hours. During this exposure to operational hazards, 2,392 disabling injuries occurred. Of this number, 67 were fatal, and 2,325 were nonfatal lost-time injuries. The total time lost from all injuries was 626,843 days, with 402,000 days chargeable to fatal injuries and 224,843 days to nonfatal.

Of the six group classifications, the open-pit group had both the lowest injury-severity and injury-frequency rates, as designated in the rules of the contest. The anthracite group had the highest rates in both injury-severity and injury-frequency. It should be stated here that only injuries and man-hours of exposure underground are considered in compiling the safety record of the anthracite-mine group.

The Six Winners

The winners in the six groups in the National Safety Competition for 1956 are:

Anthracite mines, underground: Goodspring Mine, Penag Coal Company, Goodspring, Schuylkill County, Pennsylvania.

Bituminous-coal mines, underground: Edgewater Mine, Tennessee Coal and Iron Division, United States Steel Corporation, Wylam, Jefferson County, Alabama.

Metal mines, underground: Buck Mine, Pickands Mather & Co. (Verona Mining Company), Caspian, Iron County, Michigan.

Nonmetallic mines, underground: Bell Mine, Warner Company, Bellefonte Division, Bellefonte, Centre County, Pennsylvania.

Open-pit mines: Embarrass Mine, Pickands Mather & Co. (Lake Mining Company), Biwabik, St. Louis County, Minnesota.

SALIENT FEATURES OF THE NATIONAL SAFETY COMPETITION

1956

Type of Mine	*Number of Mines*	*Man-hours*	*Fatal Injuries*	*Nonfatal Injuries*	*Total*	*Days of Disability*	*Frequency Rate*	*Severity Rate*
Anthracite	12	4,093,476	4	375	379	47,117	92.586	11.510
Bituminous-coal	69	41,038,144	31	558	589	284,748	14.353	6.939
Metal	64	23,826,380	19	667	686	155,609	28.792	6.531
Nonmetallic mineral	50	9,426,770	3	190	193	26,982	20.474	2.862
Total	195	78,384,770	57	1,790	1,847	514,456	23.563	6.563
Open-pit	87	23,440,290	2	253	255	29,341	10.879	1.252
Quarries	243	24,202,851	8	282	290	83,046	11.982	3.431
Grand Total	525	126,027,911	67	2,325	2,392	626,843	18.980	4.974

THE 32-YEAR HISTORY OF THE NATIONAL SAFETY COMPETITION

1925-1956

Type of Mine	*Man-hours*	*Fatal Injuries*	*Nonfatal Injuries*	*Total*	*Days of Disability*	*Frequency Rate*	*Severity Rate*
Anthracite	662,163,335	780	57,767	58,547	6,915,333	88.418	10.444
Bituminous-coal	1,500,576,174	1,459	61,454	62,913	13,821,744	41.926	9.211
Metal	583,768,852	447	20,072	20,519	3,938,785	35.149	6.747
Nonmetallic mineral	154,606,334	90	4,184	4,274	801,202	27.644	5.182
Total	2,901,114,695	2,776	143,477	146,253	25,477,064	50.413	8.782
Open-pit	375,122,626	102	5,801	5,903	1,001,116	15.736	2.669
Quarries	550,044,179	256	10,041	10,297	2,333,480	18.720	4.242
Grand Total	3,826,281,500	3,134	159,319	162,453	28,811,660	42.457	7.530

GOODSPRING'S SUPERVISORS: The men who supervised operations in Goodspring Mine are, left to right, Kosier Miller, Clarence Miller, Earl Clark, Edward Taigger.

Quarries: Alpena Quarry, Wyandotte Chemicals Corporation, Alpena, Alpena County, Michigan.

Anthracite Mines

The winner in the anthracite group – Goodspring Mine of Penag Coal Company at Goodspring, Schuylkill County, Pennsylvania – operated 106,162 man-hours underground, during which 14 injuries occurred that caused 98 days of disability. This resulted in an injury-severity rate of 0.92 per thousand man-hours of work and an injury-frequency rate of 131.87 per million man-hours.

In its seven years of participation in the competition the Goodspring Mine has established a record of 1.60 days lost per thousand man-hours of work, which compares most favorably with the injury-severity rate of 10.44 for the anthracite group during the entire 32-year history of the competition. The total injury-frequency rate of 75.66 for the seven years as participants in the contest is more favorable than the 88.42 established by the anthracite group for the 32-year period.

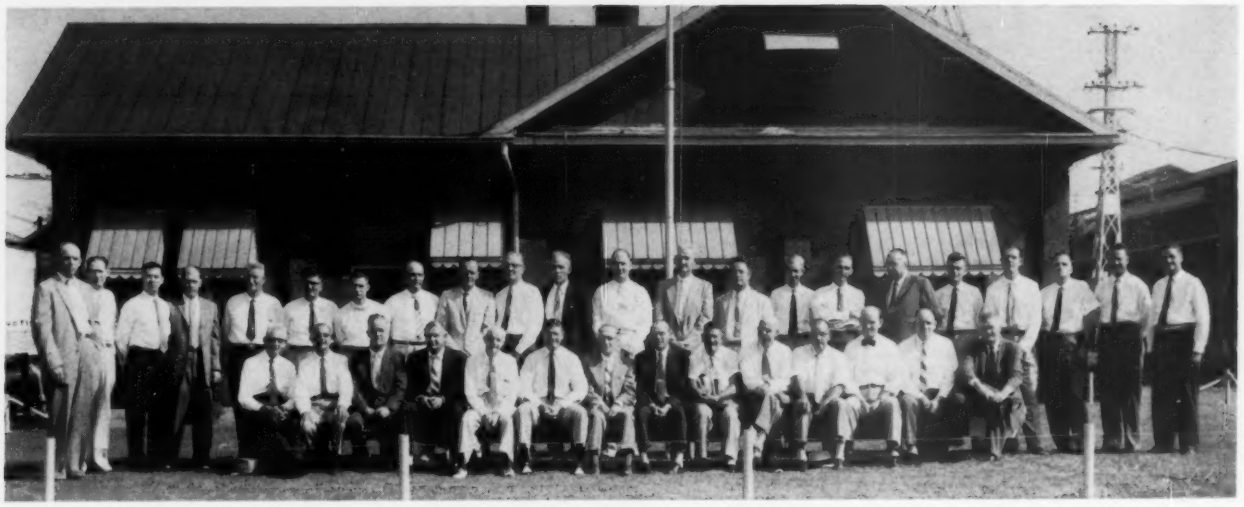
The 12 anthracite mines participating in the competition last year had an injury-frequency rate of 92.59 injuries per million man-hours. The comparable rate for this group in 1955 was 79.85, a more favorable record than was achieved in 1956. The injury-severity rate per thousand man-hours in 1956 was 11.51, slightly higher than the rate of 10.92 established in the previous year's competition.

Bituminous-Coal Mines

The winner among the 69 bituminous-coal mines participating in the 1956 competition was Edgewater Mine of Tennessee Coal and Iron Division, United States Steel Corporation, at Wylam, Jefferson County, Alabama. This mine was operated 766,644 man-hours during the year without a lost-time injury.

The Edgewater Mine has participated in 12 competitions since it was first entered in 1936. This is the first

TCI'S EDGEWATER MINERS: Some employes of Edgewater Mine of the TCI Division of U. S. Steel Corporation, Wylam, Alabama, at the main portal just before going underground. The mine won first place in the bituminous-coal group.



EDGEWATER'S SUPERVISORS: These men directed the operations at Edgewater Mine, which recorded a perfect safety record during 766,644 man-hours of work underground in 1956.

year among the 12 that it achieved an injury-free record. During the 12 years, the mine has operated for 23,751,400 man-hours with an extremely low injury-frequency rate of 18.74 per million man-hours of worktime. The continued effort of the underground employes in this mine has brought to them the distinction of winning the Sentinels of Safety trophy in the bituminous-coal-mine group in the 1956 contest.

The enrollment of bituminous-coal mines in 1956 was 69. These mines worked 41,038,144 man-hours and had 589 lost-time injuries – 31 fatal and 558 nonfatal. The injury-frequency rate of 14.35 per million man-hours of exposure to underground mining hazards was the lowest experienced in this group since the competition began 32 years ago. The comparable rate for 1955 was 16.24, the previous low record. An injury-severity rate of 6.94 days lost per thousand man-hours in 1956 was not as favorable as the rate of 5.15 recorded by this group in 1955, although it was much lower than the 32-year average rate of 9.21 for the group as a whole.

Metal Mines

For the second time in its 25 years of participation in the competition, Buck Mine of Pickands Mather & Co. (Verona Mining Company), Caspian, Iron County, Michigan, won the Sentinels of Safety trophy in the metal-underground-mines group. The winning record was 493,207 man-hours of work without a single lost-time injury.

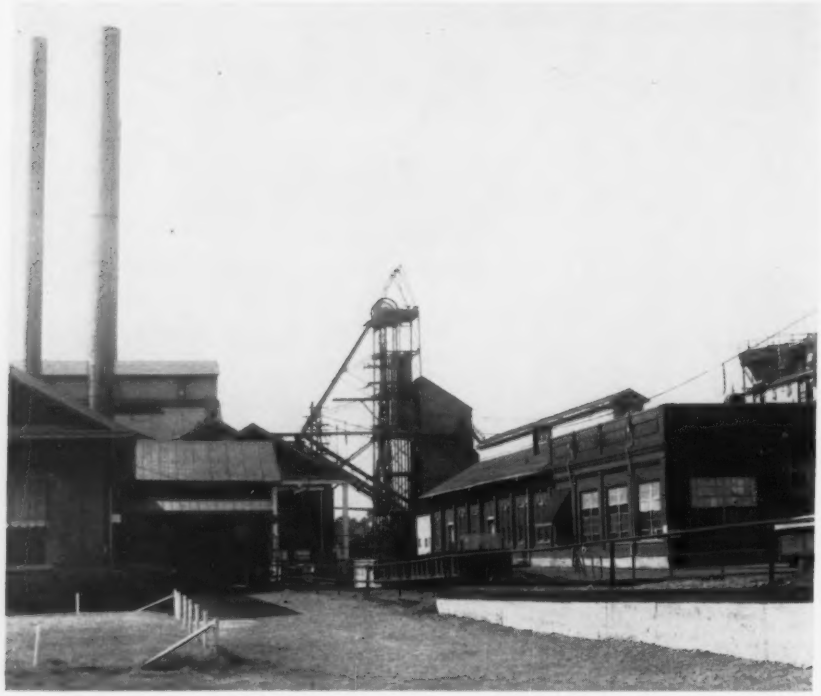
In its 25-year history in the contests, Buck Mine has been operated for more than 11½ million man-hours underground, recording a severity rate of 5.20 days lost per thousand man-hours and an injury-frequency rate of 16.57 injuries per million man-hours. The personnel of this mine is to be congratulated for a perfect record in 1956 and for their long and persistent efforts to attain safety in operations.

A total of 64 metal underground mines was enrolled in 1956. As a group, they reported an injury-severity rate of 6.53 days lost per thousand man-hours. This was considerably higher than the all-time low of 2.26 established by the group in 1955. The injury-frequency rate for 1956 was 28.79 per million man-hours of exposure to hazards underground, slightly higher than the rate of 28.20 for 1955.

Nonmetallic Mines

The Sentinels of Safety trophy for the best safety record in the nonmetallic-underground-mines group was

UNDERGROUND COAL DELIVERY: After a blast in the coal seam at a working place in Edgewater Mine, the fractured coal is moved to a loading point in a cable reel shuttle car.



OFFICE AND SHOPS: This view of some of the surface structures at Edgewater Mine of Tennessee Coal and Iron Division of United States Steel Corporation, Wylam, Alabama, includes the offices, shops, and shaft headframe.

awarded to Bell Mine of Warner Company, Bellefonte Division, Bellefonte, Centre County, Pennsylvania. This mine worked 277,540 hours in 1956 without a lost-time injury. The victory was the second straight award of the coveted trophy to this operation.

Bell Mine has participated in each of the 32 annual safety competitions and reported injury-free records in 1932, 1937, 1951, 1954, 1955, and 1956. It won the Sentinels of Safety trophy for the first time in 1955 and has the honor of retaining the trophy by winning again in 1956. All employes are to be congratulated on their concerted effort to work safely.

The 50 nonmetallic underground mines participating in 1956 were operated for a total worktime of nearly 9½ million man-hours. The injury-severity rate was 2.86 days lost per thousand man-hours, a small increase over the rate of 2.61 in 1955. The injury-frequency rate of 20.47 per million man-hours in 1956 was slightly more favorable than the rate of 20.85 in the previous year. However, both rates were better in 1956 than the corresponding average rates for the 32-year history of the competition.

Open-pit Mines

Embarrass Mine of Pickands Mather & Co. (Lake Mining Company), at Biwabik, St. Louis County, Minnesota, won the Sentinels of Safety trophy for having the best safety record among the open-pit mines enrolled in the competition. This mine operated 505,932 man-hours of exposure without a lost-time injury.

During the 13 years of participation in the contest, Embarrass Mine was worked over 8 million man-hours with an injury-severity rate of 1.17 per thousand man-hours and an injury-frequency rate of 1.96 per million man-hours. The men in this mine worked 6 of the 13 years without a lost-time injury, were awarded honorable mention three times, and won the Sentinels of Safety trophy three times – in 1949, 1950, and 1956.

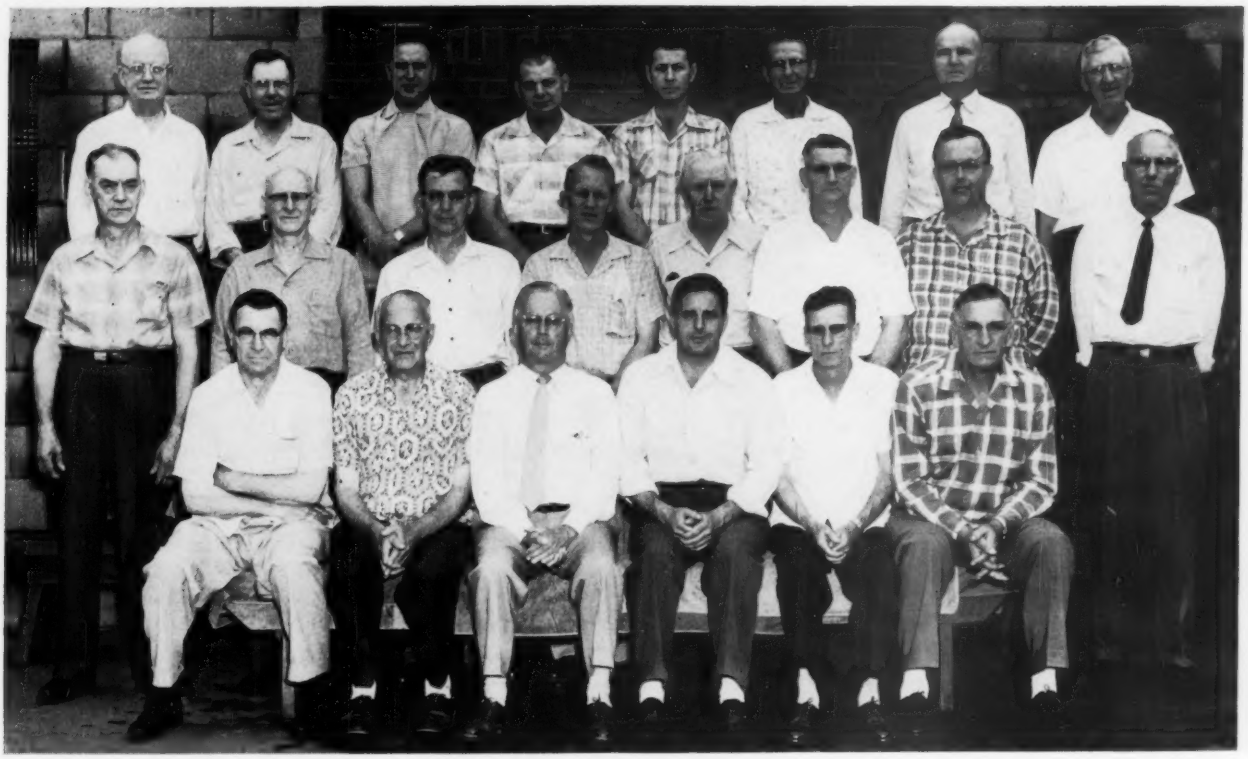
The safety record of Embarrass Mine is an enviable one when compared with the record of the entire open-pit group for 1956 – 10.88 injuries per million man-hours of employment and 1.25 days lost per thousand man-hours.

This injury experience at the 87 participating open-pit mines in 1956 compares very favorably with the 32-year average of 2.67 days lost per thousand man-hours and an injury-frequency rate of 15.74 per million man-hours.

Quarries

The Alpena Quarry of Wyandotte Chemicals Corporation, Alpena, Alpena County, Michigan, won top hon-

BUCK MINE EMPLOYES: This is a group picture of the men who work underground on the day and the night shifts at Buck Mine of Pickands Mather & Co. in Caspian, Iron County, Michigan.



SUPERVISORS – BUCK MINE: Seated, left to right, are M. Choquette, A. Lindblom, W. E. Seppanen, A. A. Martini, C. Rhino, T. LaVacque. Center row, left to right, J. Lownik, H. Peterson, F. Parvi, E. Battye, F. Comish, C. Verville, H. Ford, T. Drake. Back row, left to right, H. Neil, W. Chirgwin, W. Melchiori, J. Flaschberger, G. Anderson, J. Jurecic, J. Banovetz, F. Milanoski.

ors in the quarry group and is awarded the Sentinels of Safety trophy. The quarry was operated 474,228 man-hours in 1956 without a lost-time injury.

Alpena Quarry has participated in the competition for 16 successive years and won the Sentinels of Safety trophy in 1943, 1953, and 1956; in addition, it won honorable mention in 1951. During the 16-year period the quarry was operated over 7 million man-hours without a fatal injury, and with only 50 disabling injuries.

As the result of its excellent record the Alpena Quarry has an injury-severity rate per thousand man-hours of 0.66 and an injury-frequency rate per million man-hours of 7.12. Compared with the average rates established by its group for the 32-year history of the contest – 4.24 days lost per thousand man-hours and 18.72 injuries per million man-hours – this is a record of which the employes of the Alpena Quarry may be justifiably proud.

The 243 quarries enrolled in the 1956 competition worked over 24 million man-hours with an injury-severity rate of 3.43 days lost per thousand man-hours of work and an injury-frequency rate of 11.98 injuries per million man-hours of exposure.

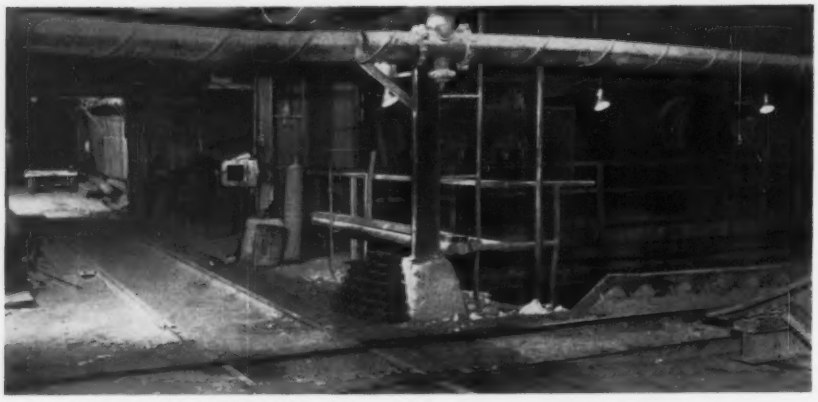
Perfect Records

Perfect safety records were established by 200 (38 per cent) of the 525 mines and quarries enrolled in the 1956 National Safety Competition. No-lost-time-accident records were reported in the following group classifications: anthracite, 1; bituminous-coal, 6; metal, 8; nonmetallic, 16; open-pit, 38; and quarry, 131.

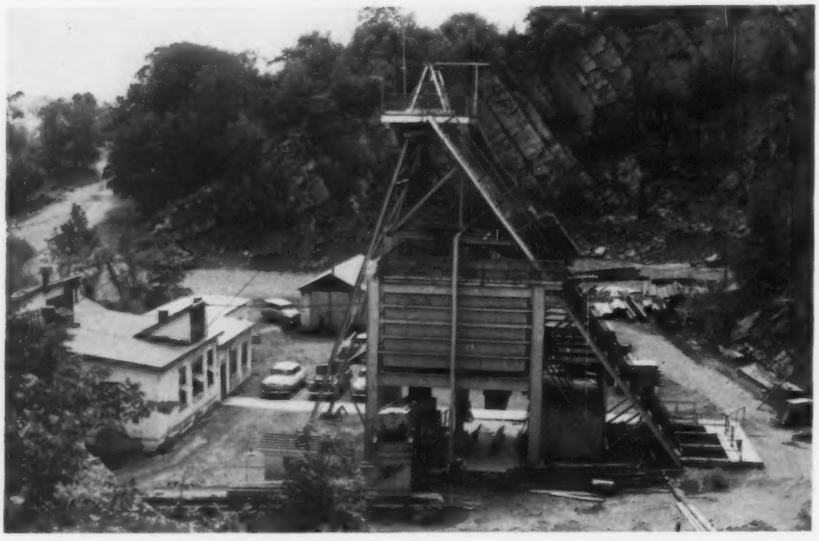
The quarry group led, with 53.9 per cent of its enrollment completing the year free of lost-time injuries. The open-pit group was second, with 43.7 per cent. The nonmetallic group, with 32.0 per cent injury-free, was

FOGARTY SHAFT – BUCK MINE: Men, equipment, and supplies are lowered and raised in the Fogarty Shaft to the various levels in the Buck Mine of Pickands Mather & Co. at Caspian, in the upper peninsula of Michigan.

BELL MINE EMPLOYES: A group picture of some of the employes at Bell Mine of Warner Company, Bellefonte, Pennsylvania. This mine was the winner of the Sentinels of Safety trophy in the nonmetallic underground mine group for the second straight year.



DOWN IN BELL MINE: This is the entry and the grizzly at the 600-ft. level in Warner Company's Bell Mine. Last year's perfect safety record was the seventh injury-free year recorded by Bell miners in the National Safety Competition.



ABOVE GROUND AT BELL MINE: The headframe at Bell Mine looms up in the center of this photograph and the mine office is at left. The concerted efforts of management and workmen have maintained safe working conditions at this property.

in third place, followed by the metal, bituminous-coal, and anthracite groups, which reported 12.5, 8.7, and 8.3 per cent, respectively.

The plants with perfect records were operated 20,111,763 man-hours during the contest year.

Among the 200 injury-free plants were 35 mines and quarries that were in operation less than 30,000 man-hours – the minimum required to be eligible to win the Sentinels of Safety trophy and the certificate awards. These plants are commended for entering the contest year after year, although they realize that they are not eligible for awards. By their participation they contribute to the mineral industry as a whole in the campaign for eliminating lost-time injuries in mines and quarries.

Committee of Award

The National Safety Competition is conducted under specific rules that were made so that competing companies could determine for themselves the degree of success of their efforts to attain top honors in the contest. Also, they may compare the past performances of their operations with the safety records of the entire industry.

To insure the confidence of the enrolled companies in the impartiality attending conduct of the competition, the rules of the contest provide for a Committee of Award comprised of seven men nationally known, but having no connection with the Bureau of Mines. A summary of the records covering injuries and man-hours at each

THE EMBARRASS MINE: This open-pit mine of Pickands Mather & Co. had a perfect safety record during 1956.

of the five leading contenders for each of the six trophies is submitted to this committee.

The Committee of Award that selected the winners of the Sentinels of Safety trophies in the 1956 competition was comprised of L. Newton Thomas, president, National Coal Association; Grover J. Holt, president, American Institute of Mining, Metallurgical, and Petroleum Engineers; Ned Dearborn, president, National Safety Council; Charles Ferguson, director, Safety Division, United Mine Workers of America; Howard I. Young, president, American Mining Congress; Franklin G. Pardee, president, Lake Superior Iron Ore Association; and G. Donald Kennedy, president, Portland Cement Association.

Rules of the Competition

Every mine or quarry in the United States is eligible to enter the National Safety Competition. To be eligible for the Sentinels of Safety trophy, however, a mine or quarry must have been operated not less than 100 days and have had a total worktime of not less than 30,000 man-hours in underground, pit, or quarry operations during the contest year. A designated official at

JOINT COMMITTEE MEETING: At this meeting of the Foremen's and Employes' Safety Committees are, clockwise, Louis Kovacich; George Mihelich; Joseph Kulaszewicz; Lester Erikson; John Rukavina; George Lerick; Gulio Guiliani; George Watts, mine superintendent; Frank Masera; Ted Renfors; John Hogan; Andrew Halberg; Ignatz Miklausich, Frank Tahija.

SHOPS AND LOADING FACILITIES: In this picture we see the shops and the ore-loading facilities at the Embarrass Mine of Pickands Mather & Co. at Biwabik, Minnesota.

each plant agrees to furnish a report of each lost-time injury and certain employment data to the Bureau of Mines.

Each injury that causes a temporary total disability is charged with the number of calendar days the injured employe is unable to work; this number includes Sundays, holidays, and all other days, whether or not the mine or quarry was idle or active.

Accidents resulting in death or permanent total disability are charged with 6,000 days. For permanent partial disabilities, such as the loss of an eye or finger, or the loss of the function of any part of the body, the charge is such part of 6,000 days as the partial disability bears to the total and permanent destruction of the employe's ability to work. The various charges for permanent partial disabilities are listed in the detailed set of rules sent to each enrolling plant.

At the close of the contest year the determined severity rate and a summary of the basic figures from which the rate is derived are sent to each plant for certification of the accuracy and completeness of the original data furnished by it to the Bureau of Mines.

Application forms for enrollment in the National Safety Competition and copies of the contest rules may be obtained from the U. S. Department of the Interior, Bureau of Mines, Branch of Accident Analysis, Division of Safety, Washington 25, D. C.

TOP SUPERVISORY PERSONNEL: Seated above, right foreground, William Hagen, Alpena Quarry's superintendent, discusses a report with Frank E. Macaulay, Wyandotte's safety director. At Mr. Macaulay's left, clockwise, are Harold MacLennon, Ed LaLonde, Clayton Miller, Elmer Olsen, Percy Thompson, Ben Raymond, Allen McNeil.

AFTER A BLAST: One of the electrically powered shovels is at work in the Alpena Quarry loading blasted limestone into a Euclid truck for delivery to the crushing plant.

ALPENA'S TRUCK OPERATORS: Some of the truck operators at the Alpena Quarry of Wyandotte Chemicals Corporation in Michigan take time out to be photographed in front of quarry motor equipment.

Awards of Certificates of Achievement in Safety

RULES of the competition provide for the award of Certificates of Achievement in Safety to each mine or quarry, other than the trophy winners, whose position in the contest was among the first four in its respective group. These mines and quarries are listed below.

Certificates are also awarded each injury-free mine or quarry that worked 30,000 or more man-hours during the 12 consecutive months of each contest. In the 1956 competition, there were 164 plants that received certificates. We regret that space limitations do not permit listing all of the recipients.

ANTHRACITE MINES

Pittston Mine, Pittston, Luzerne County, Pa., operated by P. and J. Coal Co., worked 59,360 man-hours with 4 disabling injuries that caused 86 days of disability. The injury-severity rate was 1.449.

Loree No. 3 Mine, Plymouth, Luzerne County, Pa., operated by Hudson Coal Co., worked 582,517 man-hours with 58 disabling injuries that caused 1,210 days of disability. The injury-severity rate was 2.077.

Eddy Creek Shaft Mine, Olyphant, Lackawanna County, Pa., operated by Hudson Coal Co., worked 457,324 man-hours with 35 disabling injuries that caused 1,009 days of disability. The injury-severity rate was 2.206.

Loree-Boston Mine, Plymouth, Luzerne County, Pa., operated by Hudson Coal Co., worked 397,342 man-hours with 44 disabling injuries that caused 1,114 days of disability. The injury-severity rate was 2.804.

BITUMINOUS-COAL MINES

Republic Mine, Elkhorn City, Pike County, Ky., operated by Republic Steel Corporation, worked 419,324 man-hours without a disabling injury.

D. O. Clark 7 Seam Mine, Superior, Sweetwater County, Wyo., operated by Union Pacific Coal Co., worked 212,986 man-hours without a disabling injury.

Labuco Mine, Birmingham, Jefferson County, Ala., operated by the Alabama By-Products Corp., worked 152,202 man-hours without a disabling injury.

Hernshaw Mine, Alloy, Fayette County, W. Va., operated by Electro Metallurgical Co., Division of Union Carbide and Carbon Corp., worked 80,068 man-hours without a disabling injury.

METAL MINES

Zinc Mines, Jefferson City, Jefferson County, Tenn., operated by Tennessee Coal and Iron Div., United States Steel Corp., worked 354,760 man-hours without a disabling injury.

Wenonah No. 7 Red Iron-Ore Mine, Bessemer, Jefferson County, Ala., operated by Tennessee Coal and Iron Div., United States Steel Corp., worked 294,850 man-hours without a disabling injury.

Boyd Copper, Zinc, and Iron Sulphide Mine, Ducktown, Polk County, Tenn., operated by Tennessee Copper Co., worked 207,313 man-hours without a disabling injury.

Burra Burra Copper, Zinc, and Iron Sulphide Mine, Ducktown, Polk County, Tenn., operated by Tennessee Copper Co., worked 146,572 man-hours without a disabling injury.

NONMETALLIC MINES

Jonathan Limestone Mine, Zanesville, Muskingum County, Ohio, operated by Pittsburgh Plate Glass Co., Columbia Cement Division, worked 135,283 man-hours without a disabling injury.

Pixley Limestone Mine, Independence, Jackson County, Mo., operated by Stewart Sand and Material Co., worked 121,700 man-hours without a disabling injury.

Kimballton Limestone Mine, Kimballton, Giles County, Va., operated by Standard Lime and Cement Co., worked 111,409 man-hours without a disabling injury.

Manheim Limestone Mine, Manheim, Preston County, W. Va., operated by Alpha Portland Cement Co., worked 110,505 man-hours without a disabling injury.

OPEN-PIT MINES

Mahoning Iron-Ore Mine, Hibbing, St. Louis County, Minn., operated by Pickands Mather and Co. (Mahoning Ore and Steel Co.), worked 415,968 man-hours without a disabling injury.

Sydney Phosphate-Rock Mine, Sydney, Hillsborough County, Fla., operated by American Cyanamid Co., worked 381,520 man-hours without a disabling injury.

Portsmouth Iron-Ore Mine, Crosby, Crow Wing County, Minn., operated by Hanna Iron Ore Co., worked 324,793 man-hours without a disabling injury.

Pauway No. 4 Phosphate-Rock Mine, Bartow, Polk County, Fla., operated by Davison Chemical Co., Division of W. R. Grace and Co., worked 299,531 man-hours without a disabling injury.

QUARRIES

Thornton Dolomitic Limestone Quarry, Thornton, Cook County, Illinois, operated by Material Service Corp., worked 434,020 man-hours without a disabling injury.

Bridgeport Gypsum Quarry, Bridgeport, Montgomery County, Pa., operated by Bethlehem Steel Co., worked 305,270 man-hours without a disabling injury.

Cedarville Dolomite Quarry, St. Ignace, Mackinac County, Mich., operated by Michigan Limestone Div. of United States Steel Corp., worked 290,977 man-hours without a disabling injury.

Tomkins Cove Limestone Quarry, Tomkins Cove, Rockland County, N. Y., operated by New York Trap Rock Corp., worked 272,097 man-hours without a disabling injury.

ALL-TIME WINNERS

ANTHRACITE

1925—Hazle Brook Coal Company, *Upper Lehigh Mine*, Upper Lehigh, Pa.
1926—Jeddo-Highland Coal Company, *Highland No. 6 Mine*, Jeddo, Pa.
1927—Jeddo-Highland Coal Company, *Highland No. 6 Mine*, Jeddo, Pa.
1928—Jeddo-Highland Coal Company, *Highland No. 7 Mine*, Jeddo, Pa.
1929—Jeddo-Highland Coal Company, *Highland No. 6 Mine*, Jeddo, Pa.
1930—Coxe Brothers & Company, Inc., *Tomhicken Mine*, Jeddo, Pa.
1931—Jeddo-Highland Coal Company, *Highland No. 2 Mine*, Jeddo, Pa.
1932—Jeddo-Highland Coal Company, *Highland No. 7 Mine*, Jeddo, Pa.
1933—The Hudson Coal Company, *Stillwater Mine*, Vandling, Pa.
1934—Harleigh-Brookwood Coal Company, *Laurence Mine*, Mahanoy Plane, Pa.
1935—Jeddo-Highland Coal Company, *Jeddo No. 7 Mine*, Harleigh, Pa.
1936—Hazle Brook Coal Company, *Raven Run Mine*, Raven Run, Pa.
1937—Jeddo-Highland Coal Company, *Jeddo No. 7 Mine*, Harleigh, Pa.
1938—Colonial Colliery Company, *Greenough Mine*, Natalie, Pa.
1939—The Hudson Coal Company, *Eddy Creek Mine*, Olyphant, Pa.
1940—Hazle Brook Coal Company, *Midvalley Mine*, Wilburton, Pa.
1941—Eddie & Joe Coal Company, *Eddie & Joe Mine*, Simpson, Pa.
1942—Jeddo-Highland Coal Company, *Stockton Mine*, Stockton, Pa.
1943—Morgan Coal Mine, *Oregon Slope Mine*, Pittston, Pa.
1944—The Hudson Coal Company, *Miles Slope Mine*, Dickson City, Pa.
1945—Jermyn-Green Coal Company, *Butler Mine*, Pittston, Pa.
1946—Jermyn-Green Coal Company, *Butler Mine*, Pittston, Pa.
1947—Jermyn-Green Coal Company, *Butler Mine*, Pittston, Pa.
1948—Philadelphia and Reading Coal and Iron Company, *Hunter Tunnel Mine*, Ashland, Pa.
1949—Kehoe-Berge Coal Company, *Stevens Shaft Mine*, Exeter, Pa.
1950—The Hudson Coal Company, *Birdseye Mine*, Throop, Pa.
1951—Ploskonka Coal Company, *No. 5 Hill Mine*, Archbald, Pa.
1952—Philadelphia and Reading Coal and Iron Company, *Hunter Tunnel Mine*, Ashland, Pa.
1953—The Hudson Coal Company, *Coal Brook Mine*, Carbondale, Pa.
1954—Ploskonka Coal Company, *No. 5 Hill Mine*, Archbald, Pa.
1955—Raven Run Coal Company, *Germantown Colliery*, Centralia, Pa.
1956—Penag Coal Company, *Goodspring Mine*, Goodspring, Pa.

BITUMINOUS-COAL

1925—United States Coal and Coke Company, *No. 6 Mine*, Gary, W. Va.
1926—United States Coal and Coke Company, *No. 6 Mine*, Gary, W. Va.
1927—United States Coal and Coke Company, *No. 2 Mine*, Gary, W. Va.
1928—United States Coal and Coke Company, *No. 4 Mine*, Gary, W. Va.
1929—DeBardeleben Coal Corporation, *Hull No. 33 Mine*, Dora, Ala.
1930—Penn Central Light and Power Company, *No. 1 Mine*, Coalmont, Pa.
1931—Phelps-Dodge Corporation, *Dawson No. 1 Mine*, Dawson, N. Mex.
1932—Electro Metallurgical Company, Alloy, W. Va.
1933—The Union Pacific Coal Company, *"B" Mine*, Superior, Wyo.
1934—The Union Pacific Coal Company, *"C" Mine*, Superior, Wyo.
1935—Elkhorn Piney Coal Company, *Ingram Branch Mine*, Ingram Branch, W. Va.
1936—The Koppers Coal Company, *Coxton Mine*, Coxton, Ky.
1937—The Union Pacific Coal Company, *"D" Mine*, Superior, Wyo.
1938—The Union Pacific Coal Company, *"B" Mine*, Superior, Wyo.
1939—The Union Pacific Coal Company, *Winton No. 1 Mine*, Winton, Wyo.
1940—The Union Pacific Coal Company, *Rock Springs No. 4 Mine*, Rock Springs, Wyo.
1941—Electro Metallurgical Company, *Alloy No. 2 Mine*, Alloy, W.Va.
1942—Knife River Coal Company, *Knife River Mine*, Beulah, N. Dak.
1943—The Union Pacific Coal Company, *"D" Mine*, Superior, Wyo.
1944—The Union Pacific Coal Company, *"D" Mine*, Superior, Wyo.
1945—Rockhill Coal Company, *Rockhill No. 5 Mine*, Robertsdale, Pa.
1946—Consolidated Coal Company, *Bankhead No. 2 Mine*, Bankhead, Ala.
1947—The Union Pacific Coal Company, *Winton No. 1 and 7½ Mine*, Winton, Wyo.
1948—The Union Pacific Coal Company, *Reliance No. 7 Mine*, Reliance, Wyo.
1949—The Union Pacific Coal Company, *Reliance No. 7 Mine*, Reliance, Wyo.
1950—The Union Pacific Coal Company, *Reliance No. 7 Mine*, Reliance, Wyo.
1951—The Union Pacific Coal Company, *Reliance No. 7 Mine*, Reliance, Wyo.
1952—Tennessee Coal and Iron Division, United States Steel Corporation, *Short Creek Mine*, Adamsville, Ala.
1953—The Union Pacific Coal Company, *Hanna No. 4-A Mine*, Hanna, Wyo.
1954—Alabama By-Products Corporation, *Labuco Mine*, Flat Creek, Ala.
1955—Alabama By-Products Corporation, *Labuco Mine*, Flat Creek, Ala.
1956—Tennessee Coal and Iron Division, United States Steel Corporation, *Edgewater Mine*, Wylam, Ala.

METAL

1925—New York Mining Company, *New York Mine (zinc and lead)*, Picher, Okla.
1926—Federal Mining and Smelting Company, *Muncie Mine (zinc and lead)*, Baxter Springs, Kans.
1927—The Bristol Mining Company, *Bristol Mine (iron)*, Crystal Falls, Mich.
1928—Brule Mining Company, *Berkshire Mine (iron)*, Stambaugh, Mich.
1929—Brule Mining Company, *Berkshire Mine (iron)*, Stambaugh, Mich.
1930—Penn Iron Mining Company, *West Vulcan Mine*, Vulcan, Mich.
1931—Hanna Ore Mining Company, *Harold Mine*, Carson Lake, Minn.
1932—St. Joseph Lead Company, *Balmat Mine (lead, zinc, and pyrites)*, Balmat, N. Y.
1933—Tennessee Copper Company, *Burra Burra Mine*, Ducktown, Tenn.
1934—Penn Iron Mining Company, *East Vulcan Mine*, Vulcan, Mich.
1935—Vermillion Mining Company, *Zenith Mine (iron)*, Ely, Minn.
1936—Penn Iron Mining Company, *East Vulcan Mine*, Vulcan, Mich.
1937—M. A. Hanna Company, *Hiawatha No. 1 Mine (iron)*, Iron River, Mich.
1938—Odanah Iron Company, *Cary Mine (iron)*, Hurley, Wis.
1939—M. A. Hanna Company, *Bates Mine (iron)*, Iron River, Mich.
1940—Phelps-Dodge Corporation, *Humboldt Mine*, Morenci, Ariz.
1941—American Zinc Company of Tennessee, *Grasselli Mine (zinc sulphide)*, New Market, Tenn.
1942—Tennessee Copper Company, *Boyd Mine*, Ducktown, Tenn.
1943—Penn Iron Mining Company, *East Vulcan Mine*, Vulcan, Mich.
1944—Youngstown Mines Corporation, *Newport Mine (iron)*, Ironwood, Mich.
1945—James Mining Company, *James Mine (iron)*, Iron River, Mich.
1946—Tennessee Copper Company, *Burra Burra Copper Mine*, Ducktown, Tenn.
1947—Oliver Iron Mining Company, *Soudan Mine*, Soudan, Minn.
1948—Oliver Iron Mining Company, *Fraser Mine*, Fraser, Minn.
1949—American Zinc Company of Tennessee, *No. 2 Mine*, Mascot, Tenn.
1950—Republic Steel Corporation, *Tobin Mine*, Crystal Falls, Mich.
1951—Oliver Iron Mining Company, *Soudan Mine*, Soudan, Minn.
1952—The Verona Mining Company, Pickands Mather & Company, *Buck Mine*, Caspian, Mich.
1953—Tennessee Copper Company, *Calloway-Mary Mine*, Ducktown, Tenn.
1954—Pickands Mather & Company, *Zenith Mine*, Ely, Minn.
1955—Pickands Mather & Company, *Zenith Mine*, Ely, Minn.
1956—Pickands Mather & Company, *Buck Mine*, Caspian, Mich.

NONMETALLIC

1925—United States Gypsum Company, *Lower Gypsum Mine*, Gypsum, Ohio.

1926—The Beaver Products Company, Inc., *Grand Rapids Mine (gypsum)*, Grand Rapids, Mich.

1927—The Marquette Cement Manufacturing Company, *La Salle Mine (limestone)*, Oglesby, Ill.

1928—Alpha Portland Cement Company, *Ironton Mine (limestone)*, Ironton, Ohio.

1929—Retsof Mining Company, *Retsof Mine (rock salt)*, Retsof, N. Y.

1930—United States Gypsum Company, *Lower Gypsum Mine*, Gypsum, Ohio.

1931—Retsof Mining Company, *Retsof Mine (rock salt)*, Retsof, N. Y.

1932—Retsof Mining Company, *Retsof Mine (rock salt)*, Retsof, N. Y.

1933—Retsof Mining Company, *Retsof Mine (rock salt)*, Retsof, N. Y.

1934—The Marquette Cement Manufacturing Company, *La Salle Mine (limestone)*, Oglesby, Ill.

1935—Certain-teed Products Corporation, *Gypsum Mine*, Akron, N. Y.

1936—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine (limestone)*, Bessemer, Ala.

1937—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine (limestone)*, Bessemer, Ala.

1938—Avery Salt Company, Avery Island, La.

1939—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine (limestone)*, Bessemer, Ala.

1940—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine (limestone)*, Bessemer, Ala.

1941—The United States Gypsum Company, *No. 6 Mine (gypsum)*, Plasterco, Va.

1942—Alpha Portland Cement Company, *Ironton Mine (limestone)*, Ironton, Ohio.

1943—United States Gypsum Company, *No. 6 Mine (gypsum)*, Plasterco, Va.

1944—National Gypsum Company, *Akron Gypsum Mine*, Akron, N. Y.

1945—Freeport Brick Company, *Freeport Mine (clay)*, Freeport, Pa.

1946—Certain-teed Products Corporation, *Acme Gypsum Mine*, Acme, Texas.

1947—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine (limestone)*, Bessemer, Ala.

1948—Alpha Portland Cement Company, *Ironton Mine*, Ironton, Ohio.

1949—National Gypsum Company, *Bellefonte Mine*, Bellefonte, Pa.

1950—Pittsburgh Plate Glass Company, *Barberton Limestone Mine*, Barberton, Ohio.

1951—International Salt Company, *Retsof Mine*, Retsof, N. Y.

1952—Michigan Limestone Division, United States Steel Corporation, *Annandale Mine (limestone)*, Boyers, Pa.

1953—Michigan Limestone Division, United States Steel Corporation, *Annandale Mine (limestone)*, Boyers, Pa.

1954—United States Gypsum Company, *No. 6 Mine (gypsum)*, Plasterco, Va.

1955—Warner Company, *Bell Mine*, Bellefonte, Pa.

1956—Warner Company, *Bell Mine*, Bellefonte, Pa.

OPEN-PIT AND QUARRIES

1925—North American Cement Corporation, *Security Quarry (limestone)*, Security, Md.

1926—North American Cement Corporation, *No. 5 and 6 Quarry (limestone)*, Martinsburg, W. Va.

1927—Lehigh Portland Cement Company, *Mitchell Quarry (limestone)*, Mitchell, Ind.

1928—Wakefield Iron Company, *Wakefield Open-pit Mine (iron)*, Wakefield, Mich.

1929—Michigan Limestone & Chemical Company, *Rogers City Quarry (limestone)*, Rogers City, Mich.

1930—Plymouth Mining Company, *Plymouth Open-pit (iron)*, Wakefield, Mich.

1931—Mahoning Ore & Steel Company, *Mahoning Open-pit Mine (iron)*, Hibbing, Minn.

1932—Michigan Limestone & Chemical Company, *Rogers City Quarry (limestone)*, Rogers City, Mich.

1933—Michigan Limestone & Chemical Company, *Rogers City Quarry (limestone)*, Rogers City, Mich.

1934—Michigan Limestone & Chemical Company, *Rogers City Quarry (limestone)*, Rogers City, Mich.

1935—Folsom State Prison, *Granite Quarry*, Folsom, Calif.

1936—Hanna Ore Mining Company, *Mesabi Chief Mine (iron)*, Keewatin, Minn.

1937—Illinois State Penitentiary, *Limestone Quarry*, Menard, Ill. (Separated into Individual Groups in 1938.)

OPEN-PIT

1938—Pickands Mather & Company, *Mahoning Mine (iron-ore)*, Hibbing, Minn.

1939—Pickands Mather & Company, *Scranton Mine (iron-ore)*, Hibbing, Minn.

1940—Pickands Mather & Company, *Mahoning Mine (iron-ore)*, Hibbing, Minn.

1941—Pickands Mather & Company, *Mahoning Mine (iron-ore)*, Hibbing, Minn.

1942—Pickands Mather & Company, *Mahoning Mine*, Hibbing, Minn.

1943—Pickands Mather & Company, *Danube Mine*, Bovey, Minn.

1944—Pickands Mather & Company, *Danube Mine*, Bovey, Minn.

1945—Pickands Mather & Company, *Mahoning Mine*, Hibbing, Minn.

1946—Oliver Iron Mining Company, *Rouchleau Iron-ore Pit*, Virginia, Minn.

1947—Pickands Mather & Company, *Mahoning Mine*, Hibbing, Minn.

1948—Oliver Iron Mining Company, *Spruce Open-cut Mine*, Eveleth, Minn.

1949—Pickands Mather & Company, *Embarrass Mine*, Biwabik, Minn.

1950—Pickands Mather & Company, *Embarrass Mine*, Biwabik, Minn.

1951—Oliver Iron Mining Company, *Mt. Iron Mine*, Mt. Iron, Minn.

1952—International Minerals and Chemical Corporation, *Noralyn Mine*, Bartow, Fla.

1953—Pickands Mather & Company, *Mahoning Mine*, Hibbing, Minn.

1954—Pickands Mather & Company, *Mahoning Mine*, Hibbing, Minn.

1955—Pickands Mather & Company, *Erie Commercial Mine*, Aurora, Minn.

1956—Pickands Mather & Company, *Embarrass Mine*, Biwabik, Minn.

QUARRIES

1938—Inland Lime & Stone Company, *Port Inland Quarry (limestone)*, Manistique, Mich.

1939—Inland Lime & Stone Company, *Port Inland Quarry (limestone)*, Manistique, Mich.

1940—Tennessee Coal, Iron & Railroad Company, *Dolonah Quarry (dolomite)*, Bessemer, Ala.

1941—Tennessee Coal, Iron & Railroad Company, *Dolonah Quarry (dolomite)*, Bessemer, Ala.

1942—Bethlehem Steel Company, *Hanover Quarry*, Hanover, Pa.

1943—Wyandotte Chemicals Corporation, *Alpena Quarry*, Alpena, Mich.

1944—Basic Refractories, Inc., *Maple Grove Quarry (dolomite)*, Maple Grove, Ohio.

1945—Bethlehem Steel Company, *Bridgeport Quarry (limestone)*, Bridgeport, Pa.

1946—Bethlehem Steel Company, *Bridgeport Quarry (limestone)*, Bridgeport, Pa.

1947—Tennessee Coal, Iron & Railroad Company, *Dolonah Quarry (dolomite)*, Bessemer, Ala.

1948—Bethlehem Steel Company, *Hanover Quarry*, Hanover, Pa.

1949—Tennessee Coal, Iron & Railroad Company, *Dolonah Quarry (dolomite)*, Bessemer, Ala.

1950—Michigan Limestone & Chemical Company, *Rogers City Quarry (limestone)*, Rogers City, Mich.

1951—Inland Lime & Stone Company, *Port Inland Quarry (limestone)*, Gulliver, Mich.

1952—Michigan Limestone Division, United States Steel Corporation, *Hillsville Quarry (limestone)*, Hillsville, Pa.

1953—Wyandotte Chemicals Corporation, *Alpena Quarry*, Alpena, Mich.

1954—Material Service Corporation, *Thornton Quarry (limestone)*, Thornton, Ill.

1955—United States Steel Corporation, *Hillsville Limestone Quarry*, Hillsville, Pa.

1956—Wyandotte Chemicals Corporation, *Alpena Quarry*, Alpena, Mich.

Quarrying Limestone In Texas

A summary of activities at Lone Star Cement Corporation's Maryneal quarry and plant, which produce 2,300 tons of crushed limestone a day

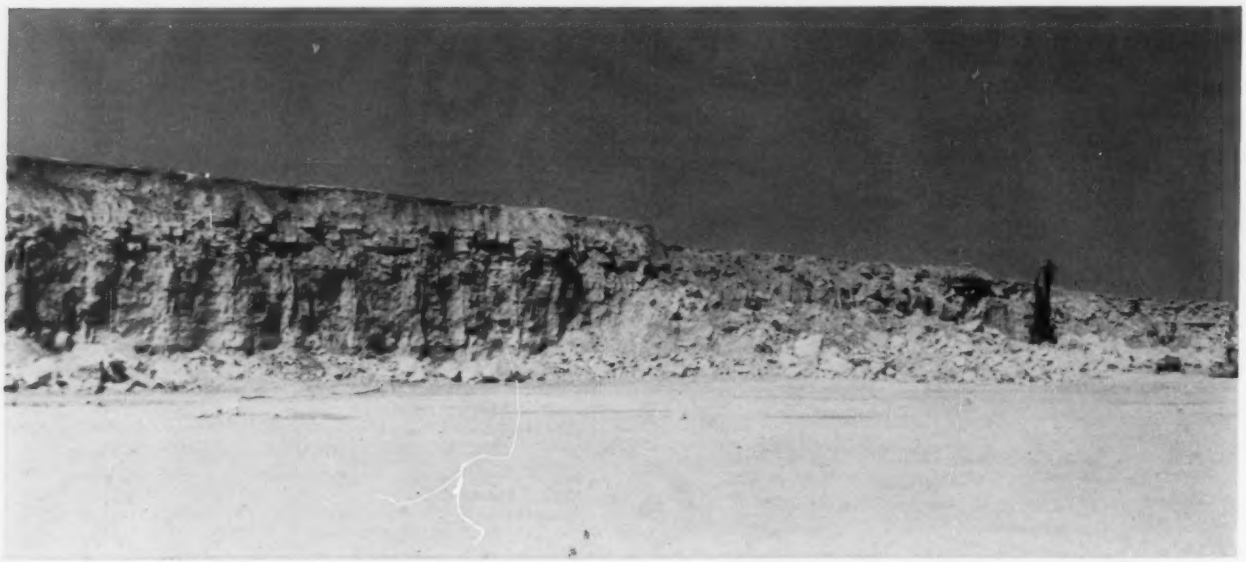
LEWIS NORDYKE*

ONE day several years ago an executive of Lone Star Cement Corporation telephoned Lee Dodge, a chemist for the corporation, and said: "Lee, we want to locate a plant to take care of the developing trade in West Texas. So, we need a supply of limestone. Could you locate a quarry for us?"

*2809 Lipscomb Street
Amarillo, Texas

It's just a bit difficult to go out and uncover limestone deposits at a particular spot where there happen to be transportation facilities. However, it happened; out there on the rolling Texas prairie stands a multimillion-dollar plant within a stone's throw of an efficiently developed quarry containing enough good limestone to last 100 years. It's right beside the Sante Fe tracks and only 26 miles from the Texas and Pacific line – in a corner made by the intersection of the railroads.

Soon after Dodge was given his assignment, he remembered that some years before he had noticed limestone outcroppings along railway grades in the vicinity of the town of Maryneal in Nolan County. Accompanied by other company chemists, Dodge prospected the area and located the needed deposits in Maryneal.

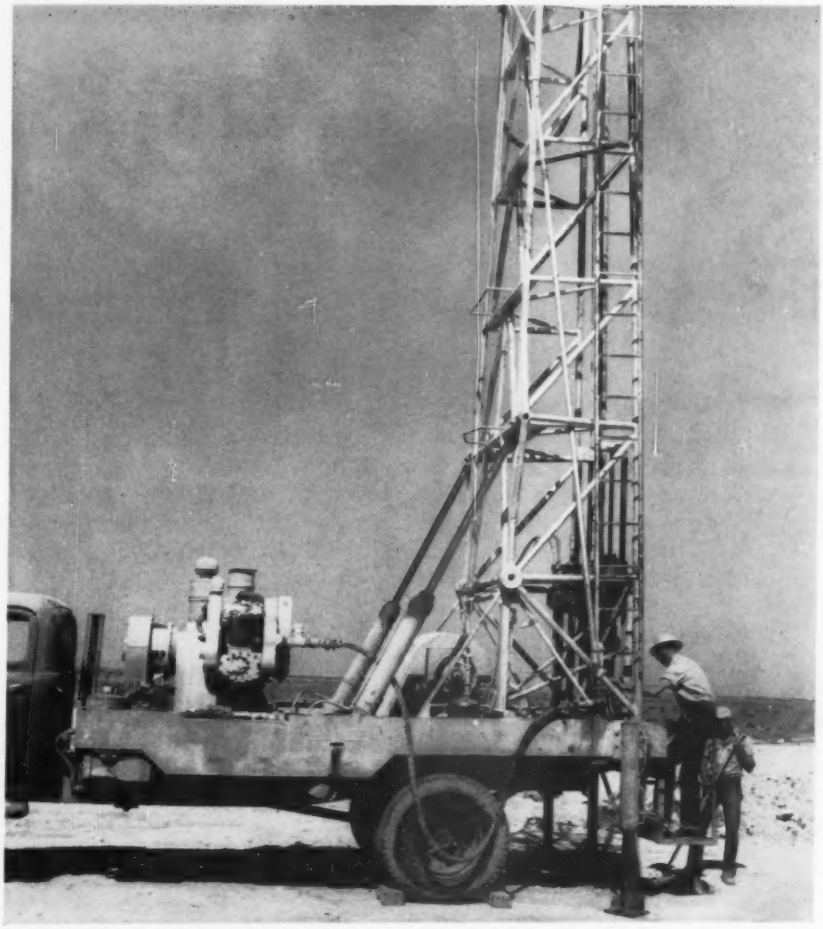


THE QUARRY FACE: This straight, clean working face of limestone in the Maryneal quarry of Lone Star Cement Corporation was developed through careful planning and attention to the details of drilling and blasting.

The Maryneal Quarry

The Maryneal quarry and plant are located in beautiful country 26 miles south and slightly west of Sweetwater, in the southern part of Nolan County. The elevation is 2,560 ft. above sea level. The undulating prairie is spotted with clumps of mesquite and scrub cedar. Wild flowers blossom in a riot of color in the springtime, and fall brings a nut-brownness to the vast terrain. The area has long been a region of farms and ranches. The Lone Star property of around 1,000 acres and the village of Maryneal, with less than 100 residents, are on a farm-to-market road connecting with Highway 70, Sweetwater to San Angelo, and Highway 80, east-west across Texas. So it is really a rural cement plant. There is plenty of parking space for the 210 employes, nearly all of whom reside in the neat, modern city of Sweetwater.

Maryneal is the third plant in Texas of Lone Star, one of the largest cement makers in the world. The first plant was opened at Dallas in 1905, and the second at Houston. Through the years, both the Dallas and Houston plants have been enlarged several times. The plant at Maryneal serves the expanding industrial development and the oil fields of western Texas and eastern New Mexico. It was completed and in operation in November of 1951 as a two-kiln plant. A third kiln was added in December of 1953, because demand necessitated increased production.



DRILLING BLAST HOLES: All holes for making primary blasts in the quarry are drilled with this Joy Rotary 225-A rig mounted on a Ford F8 truck. Drilling averages 60 ft. of hole an hour.

LOADING EXPLOSIVES CHARGES: The explosives loaded into the drill holes for primary blasting comprise a combination of Gelamite-B, 60% extra dynamite, and EP-197, primed with two lines of Primacord. Results are consistently satisfactory.

Meanwhile, the quarry was developed. The overburden covering the formation is only 4 to 6 ft. thick, consisting of soil, caliche, and about a 60 per cent limestone. No stripping has been necessary, only some blading to level the humps. The formation in the quarry working face is 98 per cent pure Edwards limestone.

During early development work in the quarry, drilling and blasting procedures followed no particular pattern. Holes for blasting were spotted wherever the greatest amount of limestone could be obtained within the shortest time. As a result, an irregular face was developing the threat of hard-to-work islands in the quarry. After discussions with explosives engineers and some experimenting, the management evolved

a long-range plan for drilling and blasting. The face was surveyed and staked carefully, and all blasting activities followed a definite plan. This gradually straightened out the zig-zags and resulted in a straight, clean working face that ranges from 15 to 45 ft. in height. Today, the engineers can tell you where the drilling and blasting crews will be conducting their operations five to ten years from now.

Drilling Blast Holes

Holes for blasting are drilled with a Joy Rotary 225-A mounted on a Ford F8 truck. The engine of the truck powers the drill. A Joy radial-type compressor blows the drill cuttings out of the holes. The drill is equipped with a leveling jack, which assures straight holes.

The depth of the blast holes varies from 15 to 45 ft., being dependent on the variation in the height of the quarry face. Where it tapers down to 15 ft., the holes are drilled 4½ in. in diameter, with a 9-ft. burden, and spaced on 16-ft. centers. The deeper holes are drilled 5⅝ in. in diameter, with a 16-ft. burden, and spaced on 16-ft. centers. Usually, from 20 to 25 holes in a row are fired at a time. Sometimes the number is increased to 32 holes. In exceptional cases, primarily to advance a particular section of the face, two rows of blast holes are fired at one time.

The Edwards limestone formation is porous and sometimes contains water. Because of this condition nearly all of the drill holes have to be bailed before the explosives charges are loaded. The formation varies from fairly soft to very hard limestone. Slab formations of the harder stone occur near the surface.

Loading Explosives Charges

In an average blast of 20 to 25 holes, the procedure of loading the explosives is as follows:

First, 50 lb. of Gelamite®-B, packed in 5-in. by 25-lb. cartridges, are placed in the bottom of a hole. Then 100 lb. of 60% extra dynamite in 5-in. by 25-lb. cartridges are loaded. This is topped with 3 ft. of EP-197 which, in turn, is followed by 50 lb. of 60% extra dynamite. The loading is completed with 4 to 5 ft. of EP-197. The charge in each hole is primed with two lines of Primacord* which are extended to the bottom of the hole. The charges are stemmed with drill cuttings and soil to within 6 ft. of the hole collars. Between each two holes are two MS connectors. When everyone and everything are in the clear, the blast is fired with a Titan Blaster. Results are consistently satisfactory. Each primary blast averages from 10,000 to 15,000 tons of broken limestone, the tonnage being governed by the height of face and the number of blast holes. The

*Reg. U. S. Pat. Off.
by The Ensign-Bickford Company

EASY DIGGING: After this primary blast was made in the quarry, the broken limestone is being loaded out by a 3½-cu. yd. Bucyrus-Erie power shovel into a 12-cu. yd. Mack diesel truck. The quarry floor is kept clean and level with a Cat D-8 dozer.

THE MARYNEAL PLANT: This overall view of Lone Star's plant at Maryneal shows the kiln feed bins in the left foreground. The kilns extend pipe-like from the bins and connect with the rest of the plant.

usual work cycle calls for one primary blast each week.

Some secondary blasting is necessary to reduce a few large boulders that break off from the slab formation near the top of the face. The boulders are dozed to one side of the quarry floor. When a pile of them has been collected, each boulder is drilled to the center with a jackhammer. A wheel-mounted Joy WK80 compressor supplies the air to the jackhammer. The holes are loaded with 1-in. cartridges of 60% extra dynamite and stemmed with soil. The charges are primed with Primacord – 20 to 30 boulders at a time. An electric blasting cap is connected to the Primacord and the blast is fired with the Titan Blaster.

Effective Safety Meetings

Safety and efficiency are important factors in all operations at Maryneal. At least once a week each foreman holds a meeting with his men to discuss specific problems. This has proved to be more effective than mass meetings of all employes. Such meetings are particularly important in reviewing blasting activities because the plant and the offices are located almost on the brink of the quarry. Before a blast is fired, each area of the works is notified and a whistle is blown alerting all employes. Guards are stationed at strategic points to prevent anyone from going near the quarry.

The magazines for the storage of explosives are set well back from the quarry. A high berm is heaped up between them and the operating areas. Each magazine is carefully checked every 30-day period. The older explosives are always used first.

The two lines of Primacord, which virtually doubles the cost of the hook-up for each primary blast, are used as a safety measure; if the line on one side of the hook-up should fail, the other line is there to detonate the charges in the blast.

The Portland Cement Association, composed of manufacturers of portland cement, maintains a safety campaign and provides a monumentlike trophy (fashioned of concrete) which is awarded each year to the plant that operated for 12 months without a lost-time accident. Lone Star's Maryneal works won this safety trophy in 1953.

Recovering Blasted Limestone

After blasts are made in the quarry, the broken limestone is loaded out by two electrically powered shovels, a Bucyrus-Erie 100-B with a 3½-cu. yd. dipper and a Marion 101-M with a 3-cu. yd. dipper. The shovels load into 15-ton Mack diesel trucks with Easton side-dump trailers. A Caterpillar D-8 dozer does the blade work in the quarry, keeping the floor clean and level.

The mill uses the dry system of processing. In addition to the limestone from the quarry, clay, gypsum, sand, and iron ore are used in making Lone Star cement. The clay comes from the company's pits at Sylvester and Longworth in Fisher County, 23 miles northeast of Sweetwater. It is hauled to Maryneal by rail and placed in the raw material storage area. The gypsum is purchased from U. S. Gypsum Com-

MARYNEAL'S SUPERVISORY PERSONNEL: Left to right, E. L. Porter, quarry foreman; W. H. Henson, superintendent; Al Imhoff, assistant superintendent; Lee Dodge, chief chemist; Clyde Radney, mill foreman; L. A. London, assistant quarry foreman.

pany's plant east of Sweetwater. It is likewise hauled by rail and stored in a special bin. Sand is purchased from a nearby landowner and is trucked in. The iron ore is shipped from Dialville, Cherokee County, in eastern Texas.

Making Portland Cement

The trucks hauling limestone from the quarry dump onto a panfeeder that discharges into a 7260 Dixie Hammermill crusher which reduces the material to minus 3-in. The crushed stone is then conveyed to a vibrating screen where the oversize is sent to the secondary crusher, a Bulldog Hammermill, which reduces it to minus ¾-in. From the crushing section the material is conveyed up a covered ramp and discharged into a 12,000-ton-capacity storage area. A 10-ton overhead crane with a 3-cu. yd. clamshell bucket distributes into the feed bins. The limestone, clay, iron ore, and sand are metered out of the feed bins and moved by drag conveyor and bucket elevator to the raw mill feed bin. From there it goes into a 9½ by 15-ft. Allis-Chalmers ball mill in which 93 per cent is reduced to 200-mesh screen. The Fuller-Kinyon conveying system moves the material to the raw mix silos from where it goes by elevator and screw conveyor to the kiln feed bins. Finally, the ground blend is screw-conveyed into the rotary kilns. Inside the kilns, which are fired by natural gas, the temperature goes as high as 2800 degrees Fahrenheit. The heat converts the blend into an incipient fusion. This hot, white material goes to an inclined grate and the temperature is lowered with a Fuller cooler.

This, in brief, is the way portland cement clinker is made. It looks something like good-sized gravel.

The clinker is moved by drag conveyor and elevator to a belt conveyor leading to clinker storage or to the clinker feed bin. From there it is metered to a drag conveyor and elevator which take it to the finish mill feed bins. The gypsum is added here, being metered at the same time from a 350-ton storage bin. The clinker and gypsum then go into the finish mills. They grind the mixture to 1800 surface area for Type 1 cement and to 2800 surface area for Type 3 cement. An efficient dust-collecting system in each of the grinding mill circuits keeps the plant clean and utilizes the dust.

Throughout this milling process numerous tests of the blend, the clinker, and the mixture of clinker and gypsum are made by the corps of chemists.

Finished Product

The finished cement goes by conveyor system to the finish cement silos. From there it goes to the pack house for sacking through St. Regis four-tube sackers. Quite a bit of the cement is not bagged but is shipped in hopper cars and trucks, which are loaded by gravity.

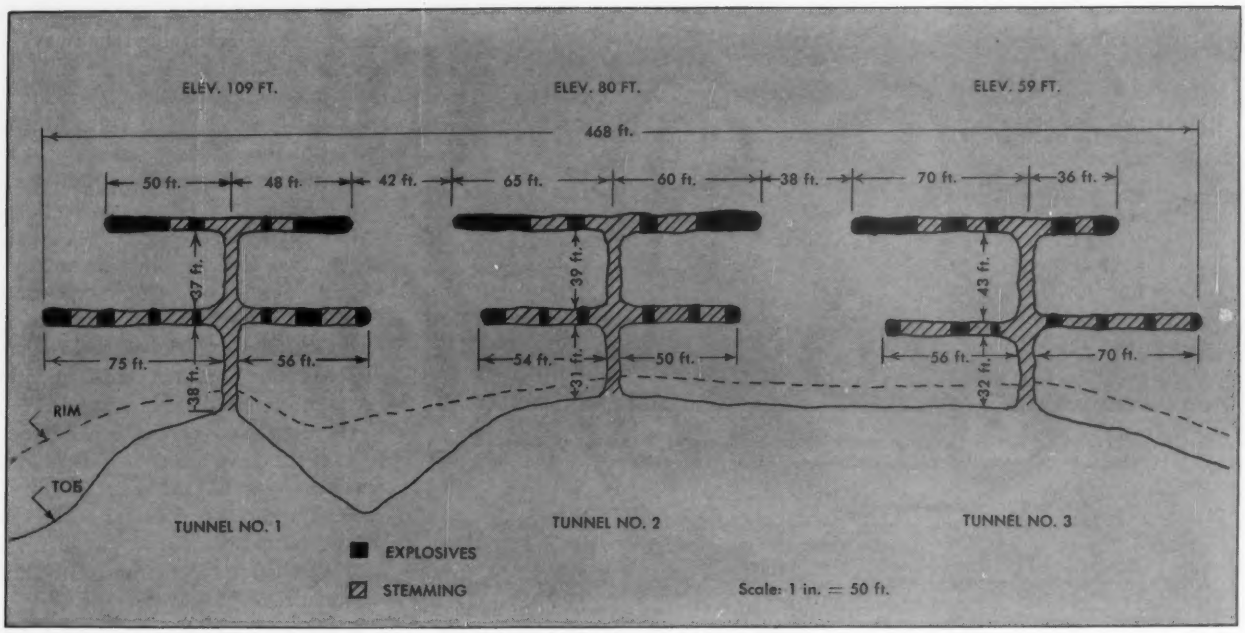
The quarry, which operates on two shifts, five days a week, produces 2,300 tons of limestone each day. The plant runs three shifts, seven days a week; it processes approximately 2,750,000 barrels of cement each year. The packing plant operates one shift, operating five days a week.

The home offices of Lone Star Cement Corporation are at 100 Park Avenue, New York City. R. A. Hummel is chairman of the board of directors and H. A. Sawyer is the president of the corporation.

All activities of Lone Star in Texas are under the direction and supervision of E. B. Mitchell, vice president. The Texas Division's headquarters are in the First National Bank Building in Dallas.

At Maryneal, W. H. Henson is plant superintendent; Al Imhoff, assistant superintendent; Lee Dodge, chief chemist; E. L. Porter, quarry foreman; and Clyde Radney, mill foreman.

OFFICE AT MARYNEAL: This attractive office building at Maryneal is typical of the modern facilities and good housekeeping methods at all properties of Lone Star Cement Corporation.



THE THREE TUNNELS: This diagram, referred to as Figure 1 in the article, shows the layout details of the three tunnels, each with four wings. The solid black sections represent the locations of the charges of explosives; the slanting lines indicate the stemming between the charges.

A Three-Tunnel Blast

IN A WISCONSIN QUARRY

Records show coyote tunnels to be the most economical method of blasting in Dresser Trap Rock Company's quarry

WILLIAM L. HARLEY*

THE detonation of 93,150 lb. of explosives loaded into three side-by-side tunnels at Dresser Trap Rock Company's quarry near Dresser, Wisconsin on May 2, 1957, brought down 870,000 tons of broken basalt onto the quarry floor. The successful result from the big blast was a fitting climax to many hours of careful thinking, planning, and hard work.

Discussions about making a big blast started during the summer of 1956 when it became evident that an additional supply of broken rock was necessary for uninterrupted operations throughout the 1957 season. This quarry has been worked continuously since 1914. Various types of drilling and blasting had been tried. But, the management always elected to continue the use of coyote tunnels for primary blasting. Several factors governed this decision, the principal one being that records showed more tons of this hard, dense basalt were broken per pound of explosives at less cost per cubic yard by the use of coyote tunnels than with any other type of blasting and drilling procedure. This was true despite the fact that secondary blasting costs were high when primary blasting was done by the coyote tunnel method.

The rock formation in the quarry is an altered basalt, probably the result of a batholith that was intruded into the pre-Cambrian granite during the Keweenawan period of the Proterozoic era. Subsequent erosion exposed this rock until it currently outcrops from Dresser, Wisconsin, along a line north to Lake Superior.

Few natural rock formations surpass this basalt in hardness, as is evidenced by the Deval abrasion loss of 3.2 and a French coefficient of 26. However, it is not so hard that it is brittle or glassy.

Combined with this hardness factor is its toughness of 19, which ranks it among the most indestructible rocks found in the crust of the earth. This is evidenced further in its performance under the Los Angeles rattler test, with only a 9 per cent loss. It is fine-grained with a columnar-shaped crystal. The absorption is 0.4 of 1 per cent, thereby assuring the least possible distortion from water, corrosive agents, or temperature changes, yet sufficiently absorbent to give a good bond.

Considering these factors, one can readily determine why a market for quantities of this rock exists many miles from the site of the quarry.

The uses of this rock are many. Road

*Hercules Powder Company
Duluth 2, Minnesota

THE QUARRY FACE: The hard, tough, dense basalt formation in the blast area over the three tunnels is evident in this close-up. The height of the quarry face ranged from 59 ft. to 109 ft.

surfacing, railroad ballast, and high-type concrete aggregate, along with custom aggregate for heavy-duty floors and filter stone for sewage-disposal plants, provide a ready market for the company's products.

Modest Beginning

The production of crushed basalt in this area was started by a number of local farmers in Taylors Falls, Minnesota, on a small scale. In 1913, the Taylors Falls' operation was hard pressed for finances and for operating know-how. Arrangements were made with John Wunder, a prominent contractor with headquarters in the Twin Cities, for his purchasing 50 per cent of the stock of the company and assuming the responsibilities of management.

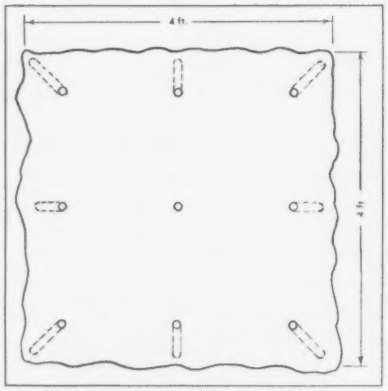
In 1914, the quarry at Taylors Falls was closed and a new quarry was developed about one mile north of Dresser, Wisconsin. The new quarry operation was called The Trap-Rock Company.

After Mr. Wunder's death in 1931, The Trap-Rock Company was operated by his heirs until 1949. In that year, the heirs sold the quarry and the crushing plant to a corporation formed by several local businessmen. The new corporation was named Dresser Trap Rock Company. Operations were started on June 1, 1949, with Jule Larson, a vice president of the company, as general superintendent.

Preparing the Tunnels

The first primary blast in Dresser Trap Rock Company's quarry was made in 1952. Sufficient rock was broken by the blast to keep the crushers busy until the fall of 1956. During the summer months of 1956, the board of directors of the company decided to make a second tunnel blast in the spring of 1957. After crushing operations had ended for the 1956 season, the north face of the quarry was cleaned and the driving of three tunnels began in the middle of December, 1956, and continued until April 9, 1957. During that time, 919 ft. of tunnel, approximately 4 ft. square, were driven into the quarry face that ranged in height from 59 ft. on the east end up to 109 ft. on the west end. Figure 1 indicates the overall layout of the three tunnels and the loading of the explosives charges and stemming in the 12 wings.

The method of tunneling in this blast was somewhat different from that used in the previous blast; two auxiliary wings were driven about halfway in from the adit of each main tunnel so that the explosives could be more evenly distributed. The better distribution of the explosive energy would provide better breakage and, also, would result in a better quarry floor.



TUNNEL-DRIVING ROUND: This diagram, referred to in the text as Figure 2, indicates the pattern and the positions of the nine drill holes in a tunnel-driving round. Each hole was drilled about 30 in. deep.

The driving of the tunnels was done during two 10-hour shifts a day, five days a week. Two men worked in a tunnel each shift. These two men tried to muck and to tram a previously blasted round and then drill, load, and fire another round, each shift.

The tramming of the broken rock from a round in a tunnel was done with small cars that hauled about 200 lb. of rock. The cars were pushed in and out of the tunnel on narrow-gauge track that was laid in the tunnel as advance was made.

An average round in driving the tunnels consisted of nine holes, each 30 in. deep. The holes were drilled with Ingersoll-Rand drifters mounted on a 3-ft. bar with jack screws. The drill steel used was 1¼ in. equipped with Timken carbide insert rock bits and Brunner & Lay tungsten carbide Rok-Bits ranging in sizes from 2 in. down to 1⅝ in. in diameter.

The holes for a tunnel round were drilled in the pattern shown in Figure 2. An average of four 1⅛ by 8-in. cartridges of Gelamite® 1-X was loaded into each hole. The charges were detonated with Hercules® No. 6 Electric Blasting Caps with 4-ft. leg wires. The cap leg wires were connected in series and fired from a 220-volt a.c. power line.

Tunnel advance averaged 2 ft. a round. The total amount of explosives used for tunneling was slightly over 6,000 lb., with an average powder factor of 10 lb. of explosives per solid cubic yard.

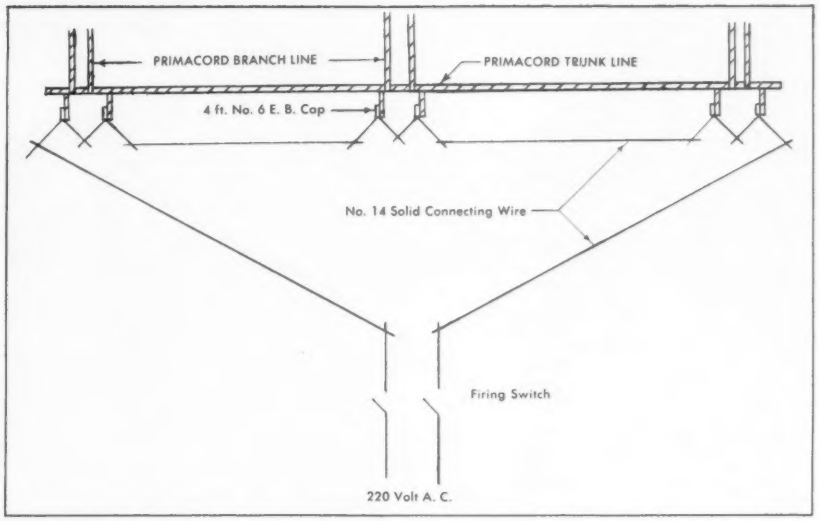
Air for the drifter drills was supplied by an electrically powered Ingersoll-Rand, double-stage, stationary compressor of 1,200-c.f.m. capacity, and a diesel-powered Gardner-Denver portable compressor that furnished 600 c.f.m. The air was carried to the tunnel adit in 6-in. pipe, then 1-in. pipe carried it to within 50 ft. of a working face. Fifty feet of air hose were used to connect the 1-in. pipe to a drifter drill.

Water was supplied to the drills from portable 10-gal. pressure tanks. The water was kept under pressure by being connected to the air line from the compressor. The tanks were connected to the drifter with a length of hose measuring 50 ft.

Tunnel Layout

Three tunnels were driven with four wings in each. Tunnels 1 and 2 were in harder, tougher rock than was Tunnel 3. The ends of the east wings of Tunnel 3 were less than 300 ft. from a railroad, a highway, and a power line. In addition, a large fault was visible along the east side of the blast area. This fault was roughly parallel to the highway, the railroad, and the power line. Because of these factors, Tunnel 3 was loaded on the basis of a powder factor of 0.4 lb. of explosives per solid cubic yard. Tunnels 1 and 2 were loaded with a powder factor of 1 lb. of explosives per solid cubic yard. A total of 93,150 lb. of explosives was used for the blast. The total length of the blast, from the most westerly end of the wing in Tunnel 1 to the most easterly end of the wing in Tunnel 3, was 468 ft.

The loading of the explosives into the pockets was started on Tuesday morning, April 23, 1957. All of it was supplied in 23G containers to expedite the loading. EP-194, a water-resistant nitro carbo nitrate in 8-in. by 50-lb. containers, comprised most of the total explosive energy loaded. A quantity of Gelamite D in 8-in. by 50-lb. containers was laced with reinforced Primacord* and used as a priming charge for the EP-194 in each pocket. As loading progressed, a reinforced Primacord branch line was run along each side of each wing to provide two firing systems for each charge. Primacord cross ties were placed across the branch lines at short intervals as assurance against the possibility of cut-offs from falling or moving rock. Friction tape was used to cover each Primacord connection knot so that the knots would remain tight throughout.



ELECTRICAL FIRING CONNECTIONS: This diagram, referred to in the article as Figure 3, shows the method used in connecting the Primacord lines, the cap leg wires, and the lead wires to the firing switch, just before the blast was detonated.

Loading Explosives Charges

The necessary amount of explosives for each pocket was transported to the tunnel adit on a small flat car on the tracks. Aluminum roller conveyors in 10-ft. sections were then connected together and extended along the floor of a tunnel from the adit to the pocket to be loaded. Men were stationed along this conveyor to keep the explosives charges moving. All of the charges were loaded during the 10-hour day shift, and the stemming was done during the 10-hour night shift, until all of

*Reg. U. S. Pat. Off. by The Ensign-Bickford Company

LOADING THE TUNNELS: The use of an aluminum roller conveyor in 10-ft. sections greatly facilitated the work of getting the explosives charges and the stemming to the various loading pockets inside the tunnel.

AT THE FIRING SWITCH: Jule Larson, the Dresser company's vice president and quarry superintendent, takes a final look around the area before giving the signal to fire the blast to Roy Olson, assistant superintendent.

the explosives were in place. Eugene Clark, quarry foreman, supervised the operations of the loading crew.

The last pocket was loaded with explosives at 11 a.m., Saturday, April 27, and the stemming of the remaining wings and tunnels was completed at 5 p.m., April 29.

A total of 300 tons of ¼-in. screenings was used for stemming. The screenings were easy to handle and did not contaminate the rock. They were hauled from stock piles near the plant on 10-ton railroad cars. These cars were spotted on the track near the adit of each tunnel. Empty wooden dynamite cases were then filled with screenings from the railroad cars and transported into the tunnels over the same aluminum conveyors that were used to transport the explosives. Each case contained about 1 cu. ft. of screenings and was easily handled by the man inside the tunnel.

After the stemming was in place, two days were required to move the track in front of the face. By late afternoon of May 1, the track and power line, as well as all other equipment, had been removed from the area in front of the blast. A total of 13,961 man-hours had been expended since the start of the tunnel-driving operations.

EXCELLENT BLASTING RESULTS: This close-up of part of the big, sloping pile of broken rock shows the excellent results obtained from this three-in-one tunnel blast. Estimates indicated 870,000 tons of broken rock were realized.

Firing the Blast

On the morning of May 2, the electric firing lines were laid from a switch near the shop to the blast area. Six electric squibs were connected in series and fired to test the 220-volt a.c. circuit. When the circuit was found to be in good order, the two reinforced Primacord branch lines at the adit of each tunnel were connected to a reinforced Primacord trunk line across the entire face. Six electric blasting caps were taped to short leads of Primacord and tied to the trunk line in the position shown in Figure 3. After making sure there was no current in the lead line and the firing switch was locked open, and after checking for stray current, the leg wires of the caps were connected in series to the firing line.

The blast was now ready to be fired, and Jule Larson checked with the flagmen stationed completely around the area. After everyone and everything were in the clear, the signal was given and Roy Olson, assistant general superintendent, closed the firing switch. There was a dull rumble as 870,000 tons of rock were pushed up into the air approximately 30 ft. and then settled down to earth.

News of the intended firing of this blast had created much interest, as was evidenced by the number of newspaper, radio, and television personnel present to witness the execution of the blast. Many thousands of people viewed the blast later when it was televised by KSTP-TV in both normal and slow motion.

After the blast, there was no evidence of thrown rock. The toe of the high pile of broken rock was estimated to be 150 ft. in front of the previous solid face. As soon as dust and smoke had left the pit, the quarry crew moved in with a 120-ton Marion-Osgood shovel equipped with a 4½-cu. yd. Eimco-Mesabi dipper and went to work clearing the way for the track crew. The rock at the toe of the pile was cleaned up in one day's time and a track was laid around the front of the pile in nine days.

Equipment

The equipment at the Dresser Trap Rock Quarry includes two 120-ton Marion-Osgood steam shovels equipped with 4½-cu. yd. Eimco-Mesabi rock dippers; four 35-ton Porter steam locomotives; thirty 10-ton side-dump cars (12 Petler and 18 Kiburn-Jacobson); one 40-ton Ohio steam crane with a 2-cu. yd. clamshell. The company has 3 miles of standard-gauge track, and the Soo Line Railroad Company has 2 miles of standard-gauge track located around the quarry and the crushing plant.

The primary crusher is a 72 by 84-in. Allis-Chalmers jaw, powered by a 650-h.p. d.c. motor. Blasted rock from the quarry is transported to the crusher in seven-car trainloads on standard-gauge track. There is a plus 4 per cent grade between the quarry and the primary crusher. Three of the Porter locomotives are used for hauling rock from the quarry to the crusher, and the other Porter locomotive is used for switching cars in the yard near the crushing plant.

The crushing plant at Dresser is equipped to produce 14 different sizes of rock but only eight sizes at any one time. The sizes of the rock product range from 4½ in. down to dust, with the major production being 1½ in. and smaller. The average production is about 1,500 tons a shift.

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This photograph of a blast of 27,000 pounds of Hercules® explosives in a traprock quarry is conclusive proof of how proper explosives technique pays off. The initial breakage was excellent, providing a sloping bank of broken rock for easy shovel digging and uninterrupted crushing and screening operations in the plant.

Achieving satisfactory results from primary blasts requires the selection and use of the right explosives materials and methods. For more than 40 years, Hercules has pioneered in the development of improved explosives techniques for quarrying, mining, seismic prospecting, and construction. A Hercules representative will welcome the opportunity to assist in solving your blasting problems.

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XR56-6

PLAIN PRIMACORD

Textile-covered, flexible and resilient. Suitable for surface trunk lines and shallow holes where tensile strength and resistance to abrasion and cutting are not required. Tensile strength 125 lbs. 1000-ft. spool 17 lbs.

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Textile reinforced, tough, resilient, flexible. Recommended for surface trunk lines and deep holes where normal strength and resistance to abrasion and cutting are needed. Tensile strength 160 lbs. 1000-ft. spool 18 lbs.

PLASTIC WIRE COUNTERED PRIMACORD

Armored with wire and covered with plastic material. Recommended for use in deep, ragged holes or with metal or fibre explosives containers, where strength and resistance to abrasion and cutting are essential. Tensile strength 300 lbs. 1000-ft. spool 33 lbs.

BLASTERS AGREE that thunderstorms, high tension lines, power cables — even t[illegible]ay radios — can be sources of stray electrical currents . . . and that the[illegible]n cause premature shots under certain conditions.

The best [illegible]feguard against such hazards is to use a detonating agent which is inse[illegible]ive to stray electrical currents.

In primary bl[illegible]ting, use Primacord as the detonating agent in each hole and also as the tru[illegible] lines to connect all holes so that they will fire in proper rotation. The en[illegible] blast can be detonated from one point on the trunk line — with fuse and [illegible]p or electric blasting cap. This final hook-up is made only when all i[illegible] readiness and when it is *safe* to fire.

In secondary blasting, use Detacord to prime each charge and to connect all charges, detonating it in the same way.

If your holes are primed with fuse and cap, connect the fuses with Quarrycord.

PLASTIC REINFORCED PRIMACORD

Covered with tough plastic material, not affected by high Summer heat or Winter cold. Waterproof—resistant to acids commonly encountered. Use for extremely deep holes, river crossings, field shots that must stand for long periods of time and in other wet conditions. Tensile strength 275 lbs. 1000-ft. spool 22 lbs.

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DETACORD

Smaller (and less powerful) than Primacord. Core of PETN is textile-reinforced and wax finished. Identified by light brown surface with cross windings of red yarn forming an "X" pattern. Resilient, flexible. An economical detonating fuse for use in secondary blasting, long hole underground blasting and pipe-line ditching. *Not* recommended for primary blasting. Tensile strength 100 lbs. 500-ft spool weighs 8 lbs.; 1000-ft spool weighs 16 lbs.

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Used to connect and ignite safety fuse in secondary blasting. Burns progressively with an external flame at the zone of burning — about one foot per second. Flexible — not affected by stray currents. 500 ft. spools. Quarrycord Connectors — 100 in a box.

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P-4

San Andreas, California . . .

another example of the cost-cutting features that bring repeat orders for Bucyrus-Erie rotaries

On the strength of the performance records of a Bucyrus-Erie 50-R rotary blast hole drill placed in operation in 1954, the Calaveras Cement Company recently installed a new Bucyrus-Erie 40-R drill at its No. 1 quarry near San Andreas, Calif.

The 40-R is drilling 9-in. holes through limestone to an average depth of 70 feet. Even though this rig has been operating only a short time, the drill operator reports the 40-R is "doing a fine job." Calaveras Cement is believed to be the first cement company in the West to convert completely to rotaries — all Bucyrus-Erie.

Among the many reasons for the outstanding success of these drills are: rotary drive with Ward Leonard electric control of rotating speed; hydraulically powered pulldown force; remote-controlled power-driven tool handling unit; and air blast cleaning of drill holes.

Two models are available — the 40-R for drilling 6¾- to 9-in. holes, and the 50-R for drilling 9⅞- to 12¼-in. holes. Holes can be drilled continuously for 32 ft. 9 in. (50-R) and 27 ft. 9 in. (40-R) before an additional pipe section has to be added.

Bucyrus-Erie rotaries can speed your drilling operations . . . cut your drilling costs. Write direct for detailed, illustrated literature.

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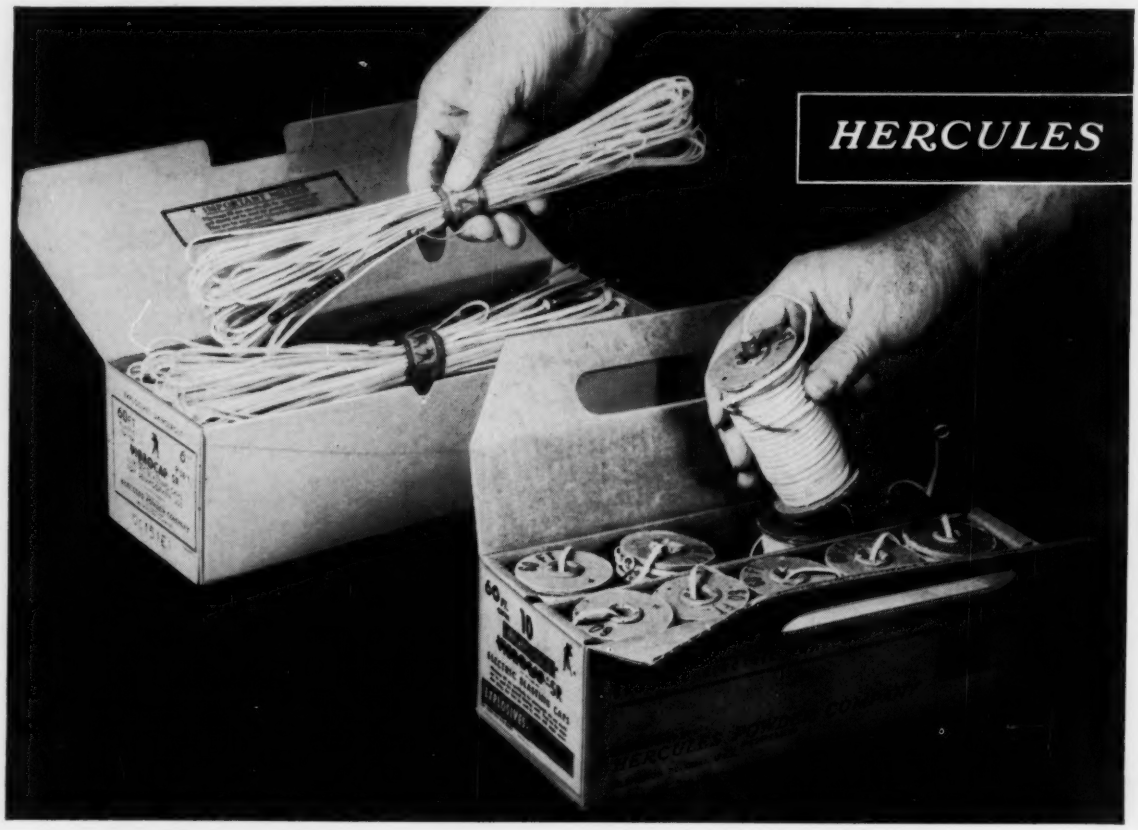

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Improved . . . High resistance to accidental discharge by static electricity, stray currents, and radio frequency energy.

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